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Mr. Isaac Newton's Considerations upon part of a Letter of Monsieur de Bercé printed in the Eight French Memoire, concerning the Catadioptrical Telescope, pretended to be improv'd and refind by M. Cassagrain.

That the Reader may be enabled the better to Judge of the whole, by comparing together the contrivances both of Mr. Newton and Mr. Cassagrain; it will be necessary, to borrow from the said French Memoire what is there said concerning them: which is as follows.

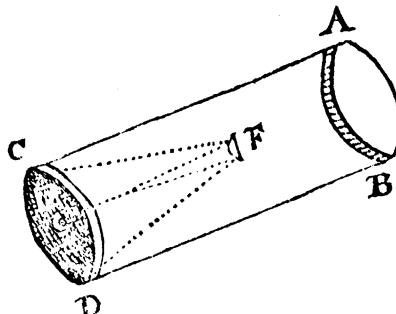
I Send you (saith M. de Bercé to the Publisher of the *Mémoire*,) the Copy of the Letter, which M. Cassagrain hath written to me concerning the proportions of Sr. Samuel Morelands Trumpet. And as for the Telescope of Mr. Newton it hath as much surprised me, as the same Person, that hath found out the proportions of the Trumpet. For 'tis now about three months, that that person communicated to me the figure of a Telescope, which was almost like it, and which he had invented; but which I look upon as more witty. I shall here give you the description of it in shoit.

ABCD. is a strong Tube, in the bottom of which there is a great concave *speculum* *CD*, pierced in the midle *E*.

F. is a convex *Speculum*, so disposed, as to its convexity, that it reflects the *Species*, which it receives from the great *Speculum*, towards the hole *E*, where is an Eye-glass, which one looketh through.

The advantage, which I find in this Instrument above that of Mr. Newton, is first, that the mouth or aperture *AB* of the Tube may be of what bigness you please; and consequently you may have many more rays upon the Concave *Speculum*, than upon that, of which you have given us the description.
 2. The reflexion of the rays will be very natural, since it will be made upon the *axis* it self, and therefore more vivid.
 3. The vision of it will be so much the more pleasing, in that you shall not be incommoded by the great light, by reason of the bottom *CD*, which hideth the whole face. Besides that you'll

you'll have less difficulty in discovering the Objects, than in that of Mr. *Newton*.



So far this French Author. To which we shall now subjoin the Considerations of Mr. Newton, as we received them from him in a Letter, written from Cambridge May 4th 1672, as follows.

S I R

I Should be very glad to meet with any improvement of the Catadioptrical Telescope; but that design of it, which (as you informe me) Mr. *Cassegrain* hath communicated 3 months since, and is now printed in one of the French *Memoires*, I fear will not answer Expectation. For, when I first applied myself to try the effects of Reflexions, Mr. *Gregory's Optica Promota* (printed in the year 1663) being fallen into my hands, where there is an Instrument (described pag. 94) like that of Monsieur *Cassegrain's* with a hole in the midst of the Object-Metal to transmit the Light to an Eye-glass placed behind it; I had thence an occasion of considering that sort of constructions, and found their disadvantages so great, that I saw it necessary, before I attempted any thing in the Practique, to alter the design of them, and place the Eye glas at the side of the Tube rather than at the midle,

The disadvantages of it you will understand by these particulars. 1. There will be more light lost in the Metal by reflexion from the little convex *speculum*, than from the Oval plane. For, it is an obvious observation, that Light is most copiously reflected from any substance when incident most obliquely. 2. The convex *Speculum* will not reflect the rays so truly as the oval plane, unless it be of an Hyperbolique figure; which is incomparably more difficult to forme than a plane; and if tru-

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ly formed, yet would only reflect those rays truly, which respect the *axis*. 3 The errors of the said convex will be much augmented by the too great distance, through which the rays, reflected from it, must pass before their arrival at the Eye-glass. For which reason I find it convenient to make the Tube no wider than is necessary, that the Eye glass be placed as near to the Oval plane, as is possible, without obstructing any useful light in its passage to the object metal. 4 The errors of the object metal will be more augmented by reflexion from the convex than from the plane, because of the inclination or deflexion of the convex on all sides from the points, on which every ray ought to be incident. 5 For these reasons there is requisite an extraordinary exactness in the figure of the little convex, whereas I find by experience, that it is much more difficult to communicate an exact figure to such small pieces of Metal, than to those that are greater. 6 Because the errors at the perimeter of the concave Object Metal, caused by the Sphericalness of its figure, are much augmented by the convex, it will not with distinctness bear so large an aperture, as in the other construction. 7 By reason that the little convex conduces very much to the magnifying virtue of the instrument, which the Oval plane doth not, it will magnify much more in proportion to the Sphere, on which the great concave is ground, than in the other design; And so magnifying Objects much more than it ought to do in proportion to its aperture, it must represent them very obscure and dark; and not only so, but also confused by reason of its being overcharged. Nor is there any convenient remedy for this. For, if the little convex be made of a larger Sphere, that will cause a greater inconvenience by intercepting too many of the best rays; or, if the Charge of the Eye-glass be made so much shallower as is necessary, the angle of vision will thereby become so little, that it will be very difficult and troublesome to find an object, and of that object, when found, there will be but a very small part seen at once.

By this you may perceive, that the three advantages, which Monsieur *Cassigrain* propounds to himself, are rather disadvantages. For, according to his design, the aperture of the instrument

instrument will be but small, the object dark and confused, and also difficult to be found. Nor do I see, why the reflexion is more upon the same *axis*, and so more natural in one case than in the other: since the *axis* it self is reflected towards the Eye by the Oval plain; and the Eye may be defended from external light as well at the side, as at the bottome of the Tube.

You see therefore, that the advantages of this design are none, but the disadvantages so great and unavoidable, that I fear it will never be put in practise with good effect. And when I consider, that by reason of its resemblance with other Telescopes it is something more obvious than the other construction; I am apt to believe, that those, who have attempted any thing in Catoptricks, have ever tryed it in the first place, and that their bad success in that attempt hath been the cause, why nothing hath been done in reflexions. For, Mr. *Gregory*, speaking of these instruments in the aforesaid book pag 95, sayeth; *De mechanica horum speculorum & lentium, ab aliis frustr à tentata, ego in mechanicis minus versatus nihil dico.* So that there have been tryals made of these Telescopes, but yet in vain. And I am informed, that about 7 or 8 years since, Mr. *Gregory* himself, at *Londen*, caused one of six foot to be made by Mr. *Reive*, which I take to have been according to the aforesaid design described in his book; because, though made by a skilful Artist, yet it was without success.

I could wish therefore, Mr. *Cassigrain* had tryed his design before he divulged it: But if, for further satisfaction, he please hereafter to try it, I believe the success will inform him, that such projects are of little moment till they be put in practise.

Some Experiments propos'd in relation to Mr. Newtons Theory of light, printed in Numb. 80; together with the Observations made thereupon by the Author of that Theory; communicated in a Letter of his from Cambridge, April 13. 1672.

I. **T**O contract the beams of the Sun without the hole of the window, and to place the prism between the focus of the *Lens* and the hole, spoken of in M. *Newton's* theory of light,

II. To